An Intelligent Neural-Wireless Sensor Network Based Schema for Energy Resources Forecast

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Abstract

The energy resources being scarce, their efficient utilization and over use remained a heated topic on International forums. The average energy consumption per person per annum is expected to cross the value of 2000 kilograms of energy/fuel resources figure. The gauged estimations are limited. There is no mechanism for regular checks on idle losses. The estimation/ predication of consumptions have been neglected for years, resulting in huge financial losses. In view of the arising problems, the paper proposes a model design based on Image Processing, Wireless Sensors Networks and Artificial Neural Networks. The model has low design cost and is ideal for miscellaneous gauged analog estimations in close-spaced industrial environments.

Keywords: *Wireless Sensor, Neural Network, Image Processing, Acquisition, Cryptanalysis, Transformation.*

1. Introduction

The energy supply demand ratio has been a serious issue in most of the countries. Mismanagement, Theft and Artificial pricing are some of the many reasons responsible for such situations. It is further compounded by the inability of users to measure their accurate needs of energy resources/ fuel consumption. A mechanism is direly needed for effective handling of these problems.

As the growing numbered heating units in a distributing environment is difficult to measure, a mechanism was developed using these already functional units so as to save time, budget and bringing in professional accuracy. The World Energy Statistics are depicted in Fig.1. Furthermore, there was a need for reduction of the application efforts.

In order to be able to deliver novel ways for efficient control based mechanism, sensors have been used to measure the pressure readings and analyzing it using a neural network. The received form factor is compared in relevance to the consumption timings and is trained off line with measured data to derive various form factors. The proposed procedure can be computed in real time on conventional digital signal processors and adapted to new boiler/ chiller units with very little effort. Fig. 8 shows a heavy energy consumption unit which mostly lack idle loss estimation equipments.

The figure shows world Fuel consumption statistics.

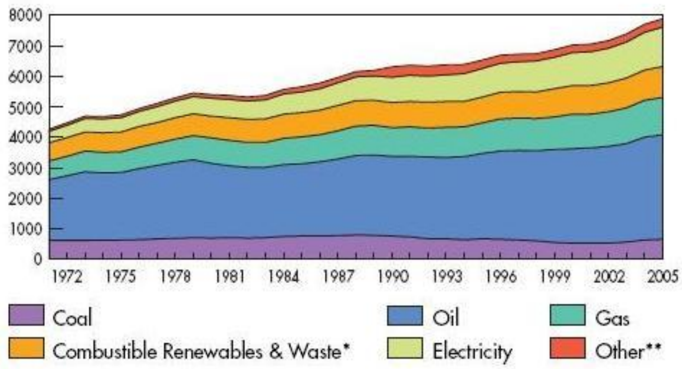

Fig.1: World Energy Statistics
(Source: IEA Key World Energy Statistics 2007)

2. Proposed Architecture

The schema proposes a series of processes combined together result in formation of a Trend exhibition/ Exhibition forecaster.

The architecture described involves the additional feature of future calculations based on calendared match date, time and usage behavior. The schema would also help in controlling idle losses. Fig. 7 shows the Idle Loss findings by American AFUE.

Fig.2: An Analog Indicator

The acquired image is stored in reference to the position of the needle/ mark showing the current value/ reading. The reading of the measurement device is trained to the Image processing unit with reference to the movement of the needle interfering spot in the plain lined measurement reading.

The reading is measured in reference to the spotted needle break point in the image as shown in fig.3. The more the alternate cross-sections of the plain, the more precise value is obtained.

The figure shows a sliced image reading with 2x2 cross plain measurements.

In case of more accuracy for a single simultaneously occurred reading, an average is required per iteration.

The sequence involves a Digital Image Acquisition camera with several lens layers focused on the indicator of a combo gauge as shown in Fig. 2.

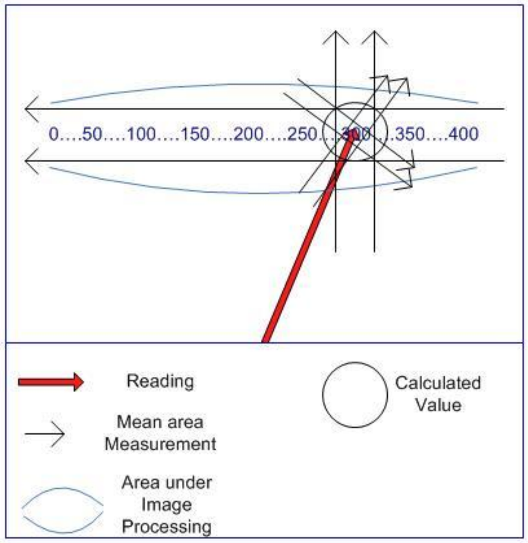

Fig.3: A Mean Live Image Slicing Schema

After acquiring the required image the plains are stored in form of sequential bits. These bits are stored in form of a table i.e. each value is entered with reference to its time and date. This effort helps in similar citation and future forecasted readings.

The whole procedure is summarized as a sequence of steps in figure 4.

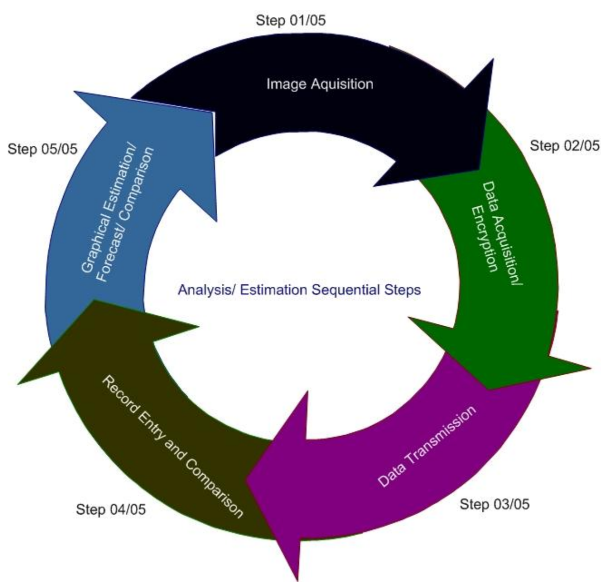

Fig4: Sequence of Steps for a Neural-Wireless Sensor Network Based Intelligent Energy Forecast Estimator

Step1: Acquire the Image from the Digital Camera.

In order to capture images in a systematic manner so as to calculate results accurately truly represent the size distribution of the sliced image screen. A consistent method may be applied to all samples so that we can make a valid comparison between two occurrences. It will avoid overlap such that the results might not become biased by omissions or repetition. Captured images over exposed surface are prone to reflected lights as well. So we have to keep the reading environment clear in term of sight. The fineness of image captured can be further enhanced/ tuned by considering its Zoom, Camera's Marked Patch Area (Slice), Side-to-side distortion Elimination (if any), Taking readings Perpendicular to the line of the sight of devices, Eliminating of Scaling Errors, Consideration of Plane margins, Number of images captured per event, and Reduction of Shadowing Effects.

Step2: Acquire the Required Data from the Image and Add Required Encryption to it

The received image can be further split into two axis table. Firstly, the one containing the MPOC (Mean Point of Occurrence) value as shown in fig. and the other containing the time of image acquisition. The received data can be encrypted there using any market available cryptographic algorithm such as the Rjindael AES Cipher (Advanced Encryption Standard) or many other available like the WinPT, PGP etc

Step3: Transmit the Encrypted Data to ANN Device.

The received data would be fed in to an Artificial Neural Network (ANN) algorithm. The reason for using the ANN is that it can perform nonlinear statistical modeling. Apart from this, it can provide a new alternative to regression, which can later be utilized for developing predictive models for dichotomous result in Time and Date based event occurrence.

Therefore, no specific network services should be presumed nor precluded, though the architecture should be optimized for a representative set of network services. Also, no special charging models should be imposed by the Authentication, Authorization, Accounting, and Charging Architecture system, and the overall architecture must be able to support very restrictive network resource usage [1].

We must take into consideration some steps to clear the line of transmission. Also we must know the channel fading effects the sensors may face.

First, wireless communication among the sensor nodes increases the vulnerability of the network to eavesdropping, unauthorized access, spoofing, replay and denial-of-service (DOS) attacks.

Second, the sensor nodes themselves are highly resource-constrained in terms of limited memory, CPU, communication bandwidth, and especially battery life. These resource constraints limit the degree of encryption, decryption, and authentication that can be implemented on individual sensor nodes, and call into question the suitability of traditional security mechanisms such as compute-intensive public-key cryptography.

Third, WSNs face the added physical security risk of being deployed in the field, so that individual sensor nodes can be obtained and subject to attacks from a potentially well-equipped intruder in order to compromise a single resource-poor node. [5]

Neural network is the best available choice here because it require less formal training, and also has the capability to read and mark complex relationships among entities, hence it can detect the occurred interactions among predictor variables and trained values. Also here the performance can be tuned via modeling instead of a data distribution.

The snaps would be marked as a boundary between the images read data versus the captured information in reference to time and date.

As soon as transmitter molecules have reached the postsynaptic side, they will be detected by specialized receptors in the postsynaptic cell membrane and open (either directly or via a biochemical signaling chain) specific channels so that ions from the extracellular fluid flow into the cell. The ion influx, in turn, leads to a change of the membrane potential at the postsynaptic site so that, in the end, the chemical signal is translated into an electrical response. The voltage response of the postsynaptic neuron to a presynaptic action potential is called the postsynaptic potential. [6]

As we can see that it is the use of a second order optimization technique from unconstrained optimization that ever created a major move in ANN algorithm training.

Human learning often involves relating two signals separated in time, or linking a signal, an action and a subsequent effect into a causal relationship. These events are often separated in time but, nonetheless, humans can link them, thereby allowing them to accurately predict the right moment for a particular action. [8]

Structuring the overall optimization in this way can lead to a number of advantages in training the network. Since the number of independent parameters in the network is reduced, it should be expected that the time taken to reach a minimum of the nonlinear cost function will be less. Secondly, the network is always in a state where the sum squared error is at a global minimum with respect to the output layer weights, since these are obtained by linear optimization. [7]

Step4: Disseminate the Information Received to their Specific Entities and Plotting the Achieved Results on Prescribed Format.

The received form factor consists of a predicted value based on readings, the more the iterations fed to the ANN device; the reliable is the calculated line graph. The received data can be customized based on the requirements/ needs of the user.

A typical form factor shown in Fig. 5 displays a daily routine form factor in an Industrial environment will fall in off timings and sharp rise in routine working hours. Fig. 6 display an annual sample trend exhibited with least usage curvature in fall season.

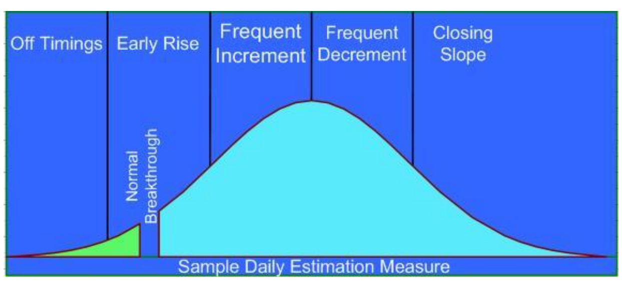

Fig.5: A Sample Daily Consumption Summary (In-Time Slots)

Fig.6: An Annual Sample Summary Based on Quarterly Trend

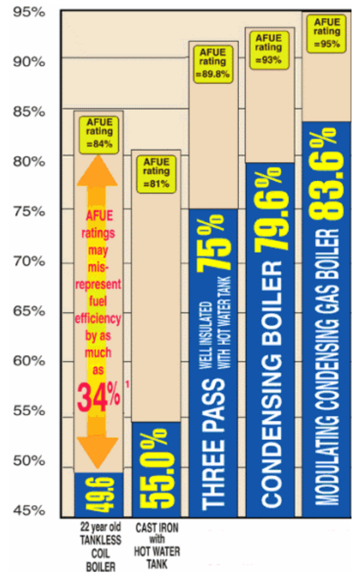

Fig. 7: Idle Loss Findings by American AFUE (C/O AGUE USA, Loss Report 2010.

3. An Intelligent Neural Sensor Network Based Energy Forecast Estimation Schema - Proof of Concept.

The wireless sensors have got an acute accuracy range when it comes to field deployments. The wireless sensors have a drawback when it comes to Intra Frequencies Spectrum Range Collision. This problem can be covered by using Multipath Synchronization Structure that removes the least possible occurred of interruptions/ alterations.

The values obtained are real-time based and have least chance of inaccuracy. For sake of comment, if the values received on the sensor are either false or altered due to operational mishandling, the abnormality in the reception is still achievable due to the involvement of pattern patching feature in Artificial Neural Network. Hence the sharp rise or fall will automatically get adjusted due to large number of similar ranging values.

This combination makes an ideal situation where Artificial Neural Network, Wireless Sensor Network and Image Processing combine together for Accuracy, Quick forecasting and Consumption Check on Energy Resource(s).

Fig.8: A Heavy Industrial Energy Consumption Unit

4. An Intelligent Neural Sensor Network Based Energy Forecast Estimation Schema - A Critical Approach

Continuing with the combination of Artificial Neural Network, Wireless Sensor Network and Image processing, it is visible that if any of the 3 technologies fail, the whole system drops out of order as they are all in-lined and interdependent on results as shown n Fig. 9.

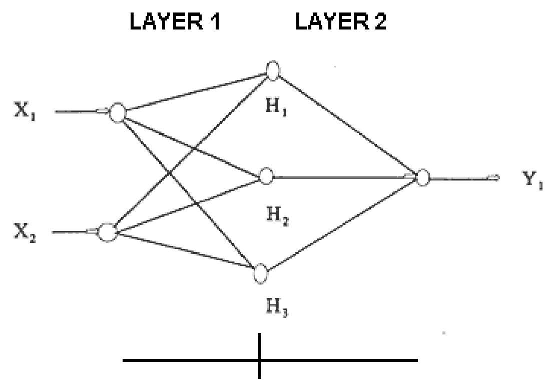

Fig.9: A Typical Artificial Neural Network

The Artificial Neural Network, has not been a very successful technology and had a very doubtful history for sensitive tasks as we saw in its history, when people termed it as a failed technology because of several reasons including requirement of immense computational effort for minimizing over fitting of large/ nonlinear near occurrence values, black box problem, large sample size for analysis and experimental basis of design.

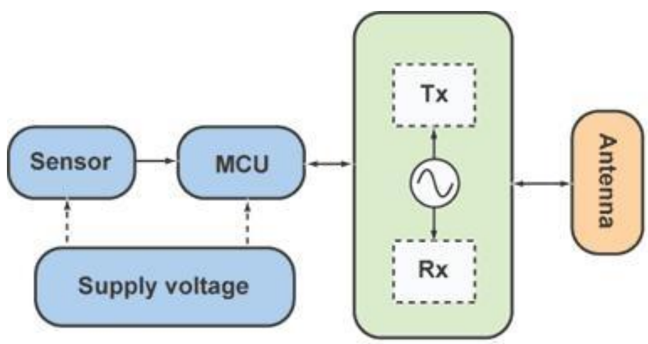

Fig.11: A Wireless Sensor Network Unit Schematic Diagram

Sensor networks are composed of a large number of sensing devices, which are equipped with limited computing and radio communication capabilities [1] as shown in Fig. 10.

They have been dropped out several times in Complex/ Continuity based calculations because of Power- Outage/ External Interference Effects.

Various solutions have been proposed to reduce the sensors energy expenditure. For instance, energy-efficient MAC layer schemes [2], [3].

Though it avoids lot of wiring and can accommodate new devices at any time, it is quiet easy for hackers to hack; it has low speed of communication and can be distracted by Blue-tooth, Wall Blocking, Microwave Interference and Attenuation etc.

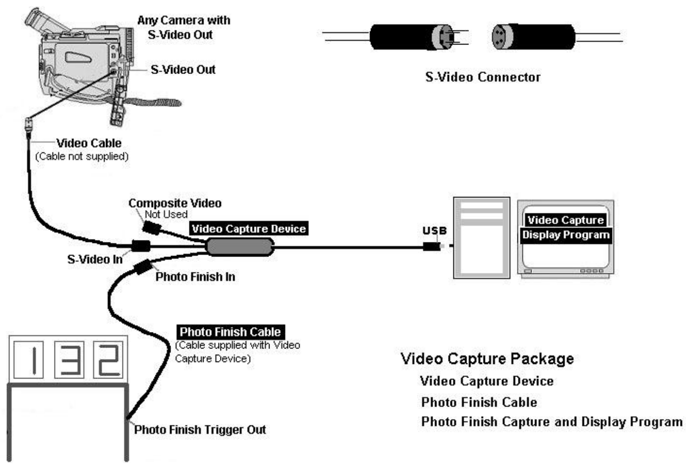

Fig.12: An Image Capturing Device Schema with Required Accessories

Image processing, in the case is solely depending upon gauge measurements, where continuous image extraction based on compass movement requires lot of computational processing and might struck the used Image Processing capture algorithm on consistent processing. An image capturing device is shown in Fig. 11.

5. An Intelligent Neural Sensor Network Based Energy Forecast Estimation Schema - An Alternate Point of View

Section IV describes the most common flaws of the suggested technologies. In review of the shortcomings initiated above, we must consider that the proposed technologies are the most widely used Information technology applications when it comes to Forecasting, Spread Environment Analysis and Controlled Readings.

The fixing in of the three nascent giant technologies make it one of the most ever flexible architecture with clarity of information transfer and entity relationships in a sequential order. The non-interdependence concept in data transfer requires simple algorithm and least computational requirements for forecasting features.

The Artificial Neural Network and Wireless Sensor Networks being doubtful in context of reliability can still be the best and only available option as they are not interrupting with the target units. There will be least conflict in Neural Network readings as the target device reading are in analog form which varies steadily without jitters or frequent jumps, resulting in smooth curved values, enabling least possible disruptions in the data transfer algorithm.

Wireless Sensor Networks problem of Power outage and External Interference effects can be sidelined in this specific scenario as the units are installed in covered / congested a space which makes the Sensors least prone to EMI, Radiation effects and the Installation falls in an Easy Serviceable location for quick repair and support operations.

These all features ultimately make the proposed architecture an ideal, flexible and efficient estimator with least possible shortcomings as show in Fig. 12.

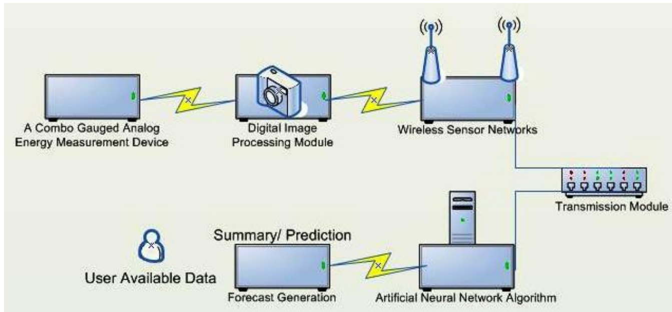

Fig.13: A Modular View of Proposed Schema

6. Conclusion

In this paper we considered a schema where Image capturing devices capture readings and encrypt them using an encryption algorithm to an Artificial Neural Network by using multihop transmissions. To save energy, sensors alternate between two operational modes of sleep and active can be modified according to needs.

The developed schema enables us to investigate the relationship among captured image in relevance to its time, an opportunity to forecast its behaviors in similar circumstances.

The system performance can be analytically derived through several ways. The described technology uses the best and latest technologies. The work is briefly supported with the advantages and flaws. If implemented, the schema is perfect for efficient functionality.

The model described is important in a way that it successfully implements all three major technologies with interrupting and working in a linear order. Moreover it is not interfering with the running system.

The model could be easily modified as per requirement basis in future. An efficient algorithm can further enhance its capability. The Model is much dependent on trained values. The more trained ANN, the quick and acute forecast would it generate.

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